25 June 2002

The failure of the CAMMICE MICS and its impact on Polar science

The CAMMICE [Charge and Mass Magnetospheric Ion Composition Experiment] consists of two sensor systems: the Heavy Ion Telescope (HIT) and the Magnetospheric Ion Composition Spectrometer (MICS), and two data processing units, one for each sensor (HDPU and MDPU). The CAMMICE MICS ceased to return scientific data on April 30, 2002. The two DPUs and the HIT sensor continue to operate and the HIT continues to return scientifically useful data.

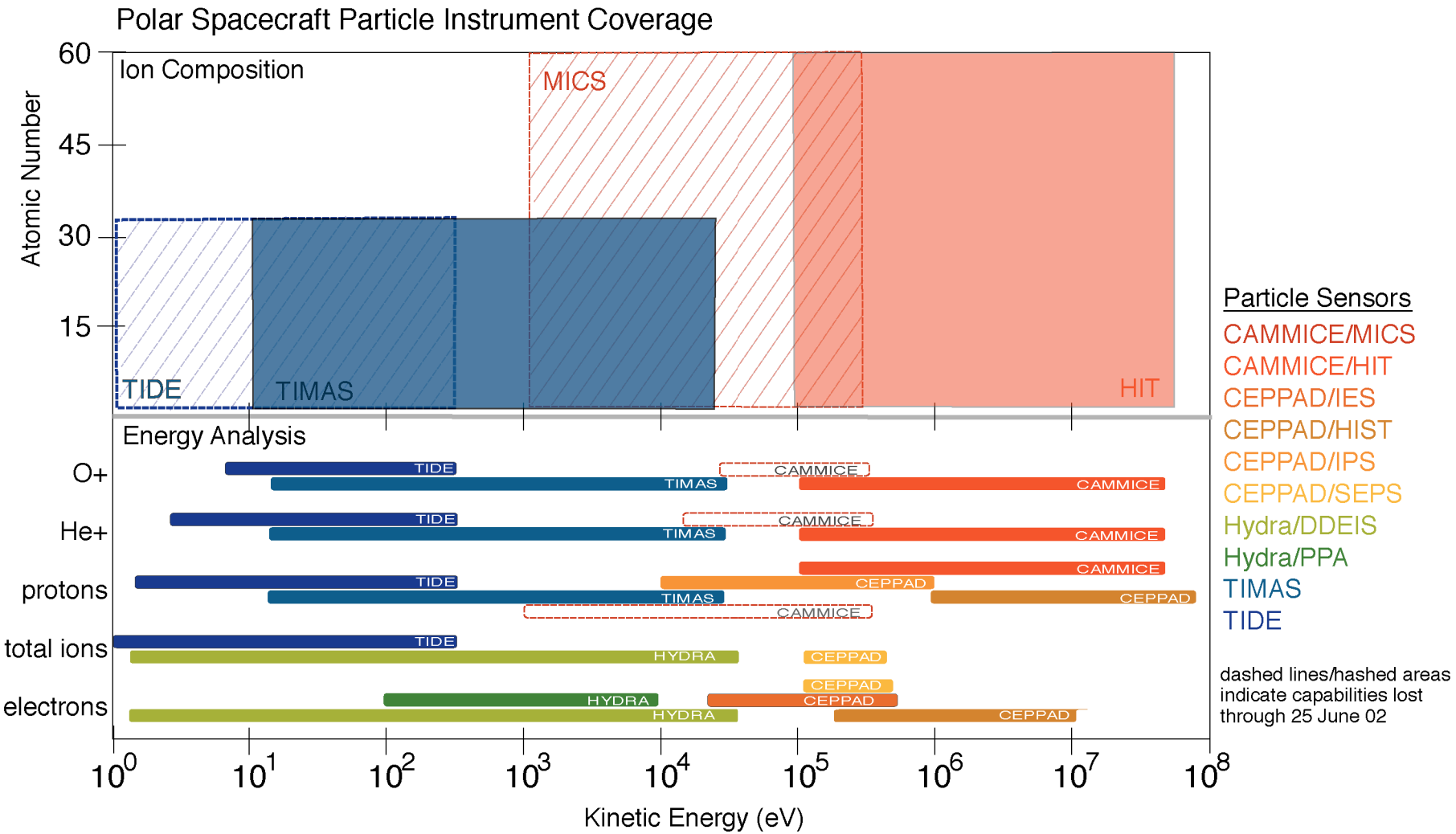
The MICS sensor used a combination of electrostatic deflection, post acceleration, a time-of-flight (TOF) measurement, and a total energy (E) measurement using a solid-state detector to determine the composition of the energetic ion fluxes encountered by Polar. The measured parameters [E/Q, TOF, and E] permitted the MICS to determine the mass, incident charge-state, and energy of the ion fluxes over the energy range from ~1keV/Q to more than 400 keV/Q.

The HIT sensor uses a three-element solid-state detector telescope to measure the rate of energy loss and the ion's total incident energy. These parameters permit a unique determination of the ion mass, elemental identification, and incident energy over the energy range from 100 keV per ion to 60 MeV with information on the compositional nature of these fluxes.

The energy analysis and composition capabilities of the full complement of particle detectors on the Polar satellite is shown in Figure 1. Dotted outlines and hash marks indicate the coverage lost since the failure of CAMMICE/MICS and the earlier failure of the TIDE mass spectrometer. The figure shows that analysis of electrons and protons over the full energy spectrum of interest to the mission are well covered. The primary impact has been to detailed composition analysis (time of flight spectrums) for the thermal particles (<15eV) and a portion of the energetic particles (~32-100keV). Good composition information remains for a majority of the energy range of interest.

The CAMMICE team has focused their science efforts on investigating the terrestrial ring current (and its composition) and demonstrating the role of the dayside cusp as the location of a major acceleration region of the magnetosphere. The team has shown the important role of ions of both ionospheric and solar wind origins in the acceleration of these particles to ring current energies in the cusp. As with most science efforts associated Polar, the analysis associated with these science topics typically requires a combination of instrumentation depending on the target plasma properties of interest. Although loss of the MICS sensor is rather a blow, further investigations on the ring current and cusp plasmas can proceed with the CAMMICE/HIT and CEPPAD sensors. The CEPPAD/IPS [Imaging Proton Spectrometer] and IES [Imaging Electron Spectrometer] will provide details of the Polar energetic ion and electron fluxes. Ion composition information to determine the origin of the energetic ions being measured will be less detailed and require additional analysis effort to identify.

The CAMMICE team continues to anticipate great science return from the overlap with the Cluster suite of four satellites. The Cluster RAPID [Research with Adaptive Particle Imaging Detectors] team is composed of members of the CAMMICE team and the joint operation of these satellite systems was and still is expected to be very important scientifically. There is more than six years of CAMMICE data and almost two years of mission overlap with Cluster and hopefully many more years of such overlap will be possible by relying on the HIT, IPS, and IES sensors to provide data on the variation of the energetic ion fluxes encountered by Polar.


Polar Spacecraft Particle Instrument Coverage
Ion Composition
MICS
TIDE
TIMAS
HIT
Atomic Number
60
45
30
15
Energy Analysis
O+
He+
protons
total ions
electrons
TIDE
TIMAS
CAMMICE
CEPPAD
HYDRA
10^0
10^1
10^2
10^3
10^4
10^5
10^6
10^7
10^8
Kinetic Energy (eV)
Particle Sensors
CAMMICE/MICS
CAMMICE/HIT
CEPPAD/IES
CEPPAD/HIST
CEPPAD/IPS
CEPPAD/SEPS
Hydra/DDEIS
Hydra/PPA
TIMAS
TIDE
dashed lines/hashed areas
indicate capabilities lost
through 25 June 02